Observation of total solar eclipses in past and in 2001

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Abstract

The past observation of total solar eclipses (1990-1999) and the plans for future eclipse in 2001 will be presented in this talk. The results of these events are presented. For the next total solar eclipse in 2001 we assume to organize theexpedition of approximately four people to the region of South Africa or Atlantic Ocean. The scientific experiments are prepared.

Introduction

The observation of total solar eclipses by the group of workers of Observatory Úpice has rather long tradition - from 1990 until now, except the 1991 year.

Two groups (situated at villages Markovo and Vayegy) observed the solar eclipse on July 22th, 1990 on Czukotka (Russia). The several experiments were performed during the 1 minute and 50 second of totality: photography of white-light corona by Mertz refractor of 1800 mm of focal length on black and white film, by 300mm focal length objectiveon slide film (Markovo) and by MTO 1000 mirror telescope (1100 mm of focal length, slide film, Vayegy).

Total solar eclipse on November 3th, 1994 was observed on the town Chapecó in Brazil. The six-member group realised some experiments during this eclipse. Except the photography of white-light corona by Mertz telescope (100/1800 mm, B&W film), the MTO telescope (100/1100 mm, slide film) we also tried to obtain the pictures of white-light corona with optical-mechanical simulation of radial filter (refractor 60/1200 mm, B&W film, partial success) and to record the course of all totality phase by full-sky camera (VHS-C video camera, partial success). For first time we used the objective Nikkor of 105 mm of focal length (color film) to detect long helmet streamers far from the solar limb. The good weather and clear sky allows observation of all 3 minutes and 52 seconds of totality.

Almost one year later we had an opportunity to observe the total solar eclipse (October 24th, 1995) in India. Our small group (two persons only) decides to observe this event from village Fateipuhr Sikhri, near of Agra. The length of totality phase was only 50 seconds and we realised only two experiments - photography of white-light corona by Rubinar mirror telescope (100/1000 mm) and Nikkor lens objective (105 mm of focal length). We have used slide film on both experiments.

The eclipse on March 9th, 1997 was observed on far east part of Siberia, in village Yerofei Pavlovich, about 2000 km on east from Irkutsk. Although the temperature decreased to 27^{o} C below zero and the coming atmospheric front threaded to blast the observation, in the end the expedition were successful. Due the big chance of failure of experiments owing to low temperatures we realised only simple experiments - photography of white- light corona by telescopes of 500 mm of focal length (Rubinar) and 105 mm of focal length (Nikkor). Moreover we realised the successful experiment of photography of solar corona in polarised light (f=300 mm, B&W film).

The February 26th, 1998 eclipse was observed by four-member group from catholic mission Don Bosco, about 70 km far from Maracaibo (Venezuela). Several experiments were realised during this 3 minutes and 50 seconds long eclipse: photography of white- light corona by telescopes of 1800, 1000, 500 and 105 mm of focal length (black&white, slide and color negative films) and record of all total phase on digital video camera.

The last total solar eclipse in the millennium (August 11th, 1999) promised the big opportunities to observe this interesting event along big part of totality path going through Europe and Asia. Observatory Upice organised two observation groups located in two different places - in France and in Romania. Due the bad weather situation the Romanian group had split into two subgroups. The firs one stayed in Romania (Nadlac), the second one had moved back to Hungary, where the weather

was better. Both groups (that means France and Romania-Hungary groups) were equipped with the same or very similar telescopes (MTO-1100 mm, Rubinar-1000 mm, Rubinar-500 mm, 105 and 135 mm objectives), the same films (color negative films and B&W films). Moreover, both groups have used the same range of exposure times. The Romania-Hungary group was in addition equipped with the telescope of 6 meters of focal length (B&W film 13x18 cm), the wide-angle objective (50 mm of focal length) with red filter and with the objective with polarisation filter. The France-group tried to take the digital pictures of solar corona with the objective of 200 mm of focal length and digital camera. Moreover, both groups were equipped with the video-recorders in full-sky settings to pick up colour changes and full-sky view during the eclipse. Unfortunately, the experiment with 6 meters telescope was unsuccessful due the bad weather in Nadlac. Furthermore, the Observatory Upice was coordinator of some Czech observing groups (any others professional and amateur organisations and individualists), with the some or similar equipment (Markova and Belik, 1999). The pictures of this coordinated observation of total solar eclipse are used to the detection of manifestation shock waves in solar corona.

More detailed information about technical and geographical conditions of above mentioned expeditions, as well as about the results, one can find on Markova et al., 1991, Markova and Belik, 1995, Markova et al., 1996, Markova et. al, 1999, Markova and Belik, 1999.

The list of main experiments, succesfully performed, and/or planned to be realised during next eclipses

1. Photography of white-light corona with long focal length objectives (1000, 1800 and 6000 mm)

   The aim of these experiments is to detect faint structures of white-light corona. We use the black and white middle sensitive roll films (6x6 cm), slide and black and white films (24x36 mm) respectively film sheets (13x18 cm) for 6000 mm telescope. The used exposure times are 1/1000 s - 2 s, respectively 2-60 s (6m telescope).

2. Photography of white-light corona the with wide-angle objectives (500, 300, 135, 105 and 50 mm of focal length)

   The aim of these experiments is to detect large-scale structures of white-light corona. We use the black and white, slide and color negative middle sensitive films (24x36 mm). The used exposure times are 1/1000 s - 2 s.

3. Photography of corona in polarised light ($+60^o$, 0^o, -60^o)

   The aim of this experiment is to get information about distribution of polarised light in corona. We use the telescopes of 300 mm of focal length with the black and white film (24x36 mm and 6x6 cm) of middle sensitivity.

4. Photography of the white-light corona with optical-mechanical simulation of radial filter with occulting disc

   For this experiment we use the telescope of 1200 mm of focal length with the occulting disc placed in front of objective (literature) and black and white film (6x6 cm) of middle sensitivity.

5. Taking a movie of the eclipse

   This experiment, intended for detection of fast changed in solar corona, use the video recorder or 16 mm camera in attachment with long focal objective (1200 mm) to record selected parts of solar corona. By comparison of individual pictures we would like to detect some fast and faint structural changes in corona.

6. Taking a movie of all the eclipse by video-recorder in full-sky setting

   This experiment tries to detect "flying shadows" and the next events during eclipse.

7. Radio-experiments

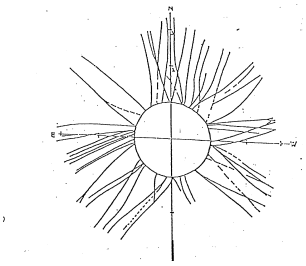
These experiments, exploited especially the SEA signals and the signals from radio-bacon, reflected by the ionosphere (which reflectance depends on immediately solar activity), are focused mainly to the determination of response of ionosphere on vanish of solar activity.

Main purposes and results

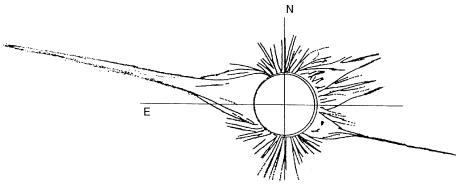
1. Structures of white-light corona

The pictures of white-light corona obtained with both wide-angle and long-focus objectives on slide, color and black and white films, allows to determine both large and tiny scales structures in the corona. We use similar redrawing of structures from individual snapshots, as well as complicated graphical and mathematical methods to obtain more detailed resolution. The examples of coronal structures are shown on Fig. 1.

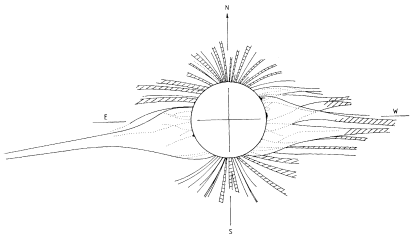
Fig. 1: Coronal structures obtained during individual eclipses1990-1999



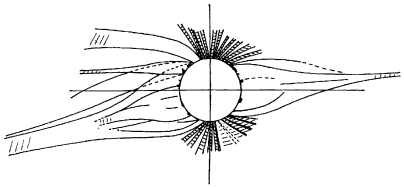
a) 1990



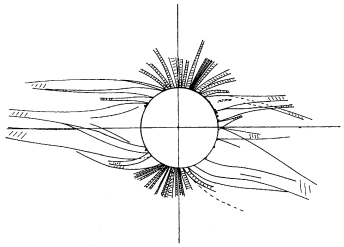
b) 1994



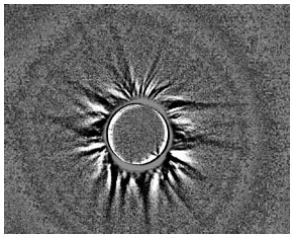
c) 1995



d) 1997



e) 1998



f) 1999 (digital camera)

2. Specification of shape of white-light corona

We use the method of isodensities to find the value of ellipticity, which indicate the flattening of corona. Obtained ellipticity well corresponded with phase of activity of solar cycle (see Tab. I).

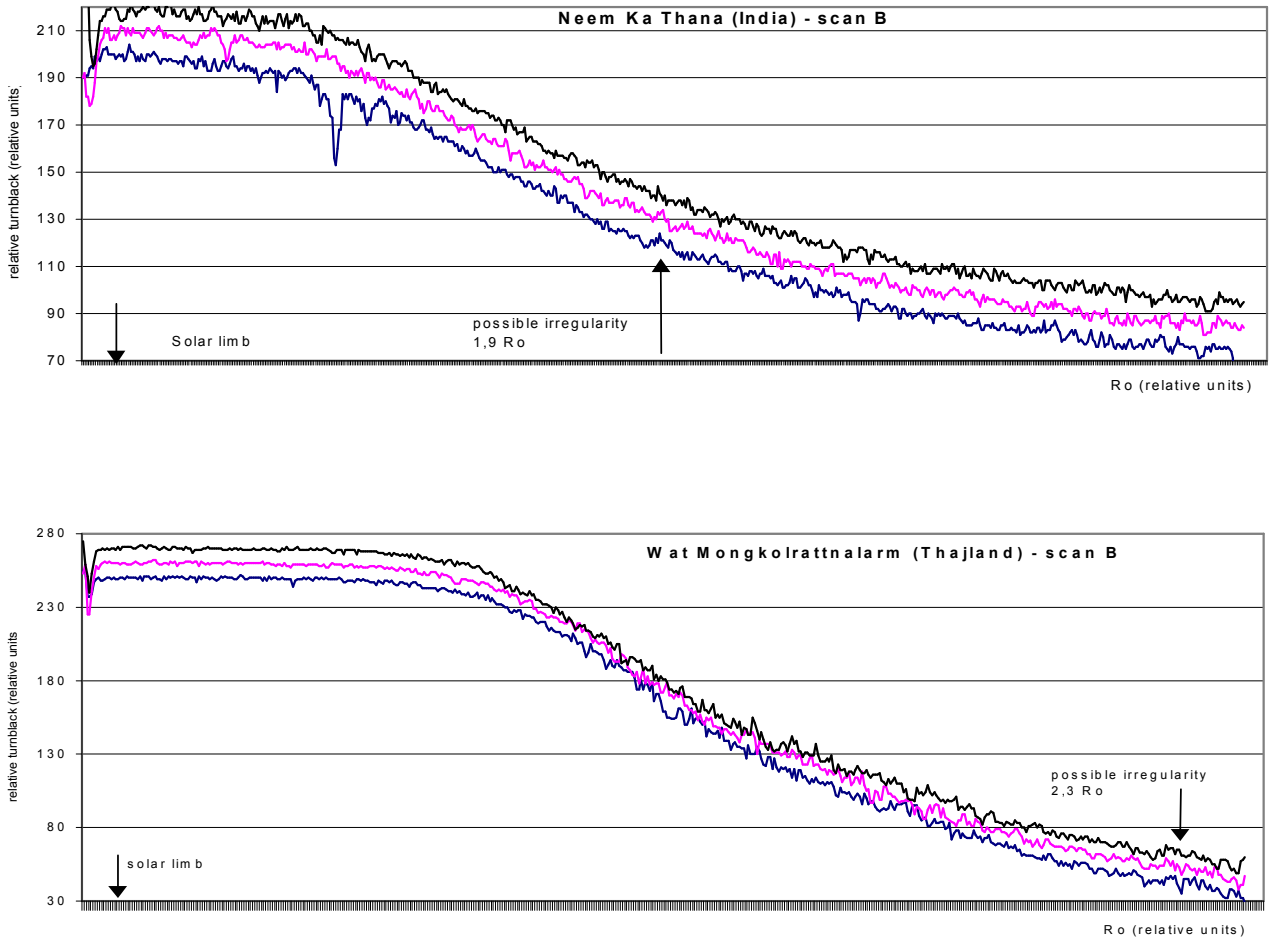
Tab. I:

eclipse	ellipticity	relative number	remark
22.7.1990	0,04	143	near the solar maximum
3.11.1994	0,27	34	
24.10.1995	0,27	25	near the solar minimum
9.3.1997	0,21	18	
26.2.1998	0,22	45	
11.8.1999	0,087	52	near the solar maximum

3. Detection of structural changes in solar corona

The long-time delay between different observation places along totality path during solar eclipse allows studying structural changes caused by moving of plasma or shock waves in solar corona during this (or these) time interval(s). At first time we tried to find these manifestation on 1994 eclipse, but the first significant results we obtained during 1995 eclipse. We had an opportunity to compare time-different pictures of solar corona obtained by similar telescopes in India and Thailand. We found the typical speed of manifestation of shock waves in long helmet coronal streamers 150-300 km/s (Belik et al., 1999). Unfortunately, we should note, that the manifestation of studied events is very weak and the level of almost all measurements is very close to the instrumental noise. The example of measurement of decrease of density along the long helmet streamer with some irregularities caused probably by above-mentioned effects is shown on Fig. 2. We process amount of pictures obtained during 1999 eclipse by many expeditions situated along totality path.

Fig. 2: Radial scan along long helmet streamer (India -Thailand, 1995), where possible irregularities



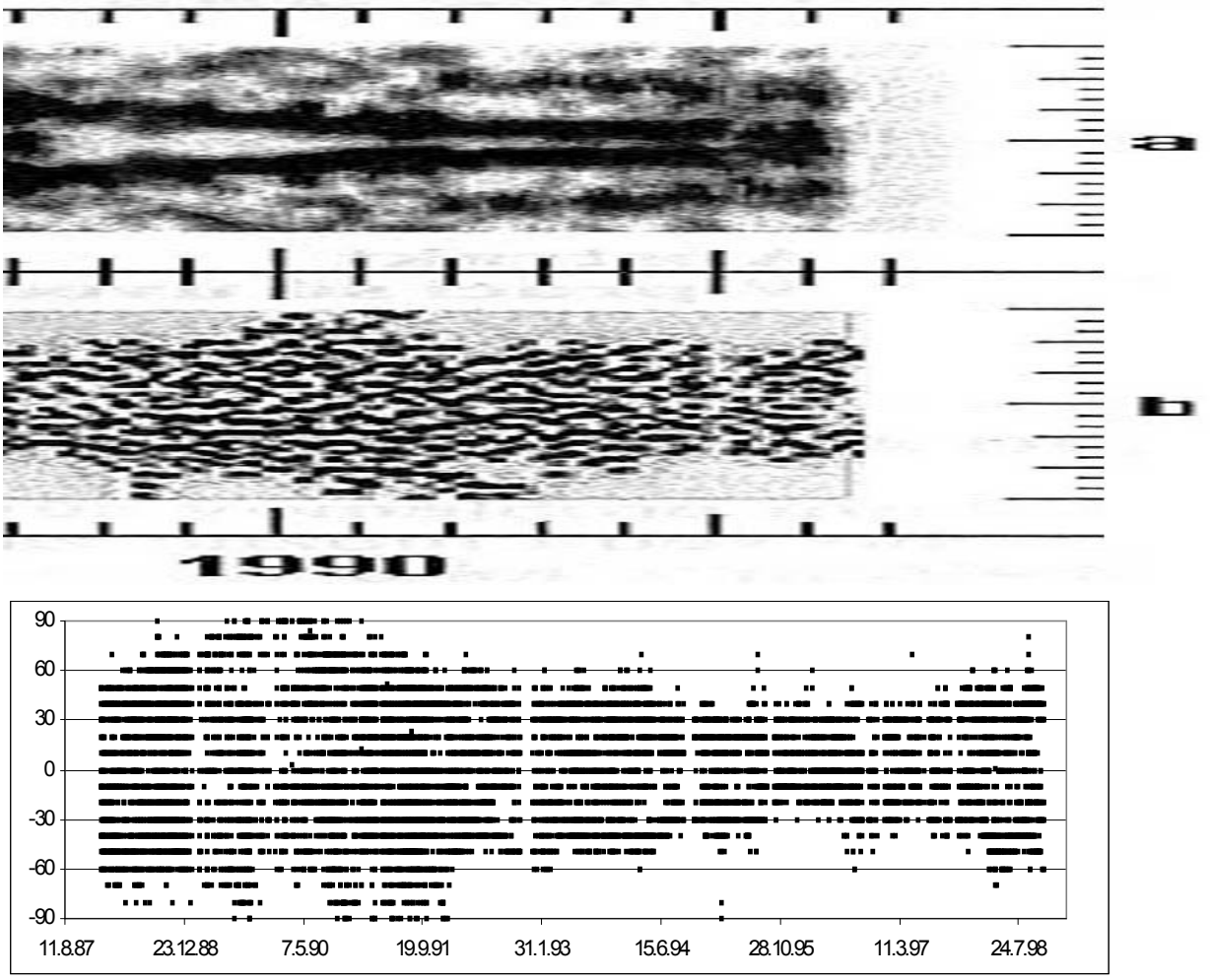
are shown

4. Research of relations between development of coronal structures and others manifestations of solar activity.

The aim of this research is focused on relations between distribution of long helmet streamers and prominences. As the observations of total solar eclipses during the cycle of solar activity shows,

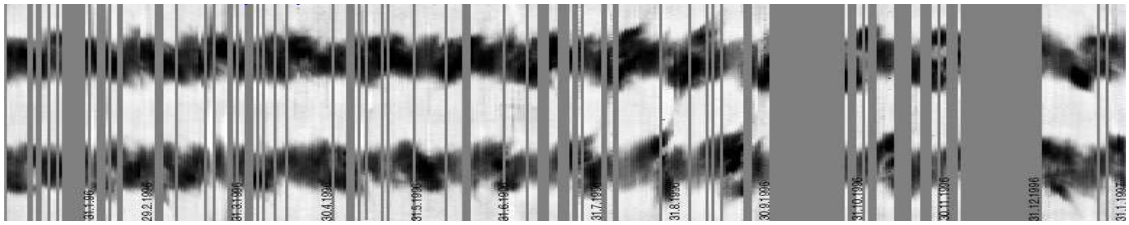
distribution of helmet streamers and prominences, as well as their migration toward solar poles and back, shows similar tendency (Belik et al., 1999). Enhancement of these results with the pictures from terrestrial and satellite coronographs encourage this theory (Markova et al., 1999). The correlation between distribution of solar prominences and helmet streamers during solar cycle is shown on Fig. 3.

Fig. 3: Distribution of green corona (a), prominences (b) and helmet streamers during solar cycle



The examples of "synoptic maps" of coronal structures, obtained from daily pictures from MK3 coronograph on Mauna Loa, when the annular cuts around whole Sun at the hight 0,2 Ro above limb was made, is shown on Fig. 4.

Fig.4: Examples of "synoptic maps" of coronal structures (long helmet streamers) from 1988-1998

1996 

Conclusion

The shown results are rather hopefully, especially in above mentioned articles 3) and 4). Moreover, as these research shows, it is necessary to improve not only processing methods (mathematical and graphical), but also the observation techniques (especially improving of resolution of obtained pictures). Therefore using of more powerfully long focus telescopes is recommended.

At last but not least we will continue in research of others manifestation of solar activity and its influence not only to solar corona but especially its influence to the terrestrial neighbourhood.

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